

Airport Citizen's Advisory Team

Sierra Crest Automated Weather Station Study

Introduction

ACAT has researched the feasibility of placing an AWOS (Airport Weather Observation System) at the Sierra Crest to provide up to the minute weather conditions for private pilots who are in route to the Truckee Tahoe Airport or who are transiting the TTAD community.

Pilot and Community Safety are paramount in the operation of the Truckee Tahoe Airport. Providing reliable weather conditions for the ever changing conditions in the Tahoe Basin and Sierra Crest is of utmost importance to private pilots and the general public. For a five month period from October 2014 to March 2015 there were over 2200 flights or a minimum of 32% of our air traffic crossing the Sierra Crest. This does not include traffic which is transiting our community on its way to or from the Bay area and points East. Staff has captured flight traffic for the area on the summit from Alpine Meadows (Ward Peak) to Donner Summit, from ground level up to 15,000 msl. This "gate" captures air traffic traversing the summit area on its way either to or from the Truckee Tahoe Airport.

Providing reliable weather data along the Sierra Crest is even challenging for the National Weather Service which must rely on weather stations erected by other agencies both public and private. These weather reporting stations vary in technological sophistication and reliability due to the age of the equipment and oftentimes harsh meteorological conditions (130 plus mph winds, icing, etc.). There is currently no FAA certified AWOS reporting station anywhere along the 500 mile Sierra Crest. Because of its strategic location the area between Alpine Meadows and Castle Peak is a main pathway of low level flights transiting the northern Sierra Nevada.

AWOS is a suite of weather sensors of many different configurations that are either procured by the FAA or purchased by individuals, groups, airports, etc. They are required to meet FAA standards to be able to report specific weather parameters. AWOS systems can be purchased from three different contractors in the United States. For purposes of this report AWOS configurations considered have been limited to the following:

Non-Federal AWOS

AWOS I: Wind Speed, Wind Gust, Wind Direction, Variable Wind Direction, Temperature, Dew Point, Altimeter Setting, and Density Altitude

AWOS II: Same as AWOS I + Visibility, and Variable Visibility

AWOS III: Same as AWOS II + Sky Condition, Cloud Height and Type

One of the specific reasons for placing an AWOS on the Sierra Crest is to provide automated voice reporting to approaching low altitude pilots about current weather conditions at the crest. This would assist pilots in determining if conditions are acceptable to fly at low altitudes over the Crest. Because of the weather dynamics at the Crest, visibility can change within minutes and wind speed can be deceptive to the Bay Area pilot.

In addition such a station would provide accurate reliable data to the National Weather Service, other governmental agencies and our surrounding community. There is a high degree of interest by the National Weather Service and the Desert Research Institute to partner with us. Additionally Squaw-Alpine Resort has been very receptive to our preliminary communications with them regarding placement. A letter of endorsement is attached from the [Reno National Weather Service](#).

Study Context

Analysis for this project examined the following areas to determine whether or not such a system is feasible and should be recommended for action by the TTAD Board of Directors.

- **System Placement**
 - Public vs. Private land
 - Geographic location
 - Existing or new infrastructure necessary for operation

- **Component Considerations**
 - Hardened components for inclement weather
 - New equipment or hybrid with existing equipment
 - Voice reporting component FAA/FCC
 - Telemetry reporting NWS/ DRI / Mesowest

- **Cost**
 - Equipment
 - Installation
 - Long term maintenance / lease
 - Possible partnership with existing weather reporting sites

- **Certification**
 - FAA requirements / waivers
 - FCC requirements
 - County permitting if necessary
 - United States Forest Service requirements

- **Alternatives for mountain top weather data**
 - New FAA certified AWOS
 - Augmentation to existing weather service station
 - Do nothing

ANALYSIS

➤ System Placement

When considering cost and convenience as major factors it would be most advantageous to place the system in a readily accessible location, free of a long term lease which requires annual payments for vault/tower access. In addition a location with access to power, phone and internet connectivity would be ideal. Generally speaking placement on state or federal property would most likely result in the most complex property arrangements.

The locations considered for this study were:

1. Mt Lincoln at the top of Sugar Bowl (current DRI weather site) 8200 ft.
2. Squaw Peak - FAA VOR site on Forest Service land 8885 ft
3. Squaw Peak - Private Squaw Valley Ski Resort Siberia ski lift site) 8553 ft.
4. Alpine Meadows – Ward Peak / Summit chair lift area 8400 ft.

Each of these sites have benefits and draw backs. See appendix page 13 for more specific analysis of each site. Other sites along the Sierra Crest were originally considered but rejects for a variety of reasons.

Mt Lincoln located at the ridgeline of the Sugar Bowl Ski resort has an existing weather station operated by the Desert Research Institution in Reno Nevada with some assistance from Sugar Bowl Ski Resort on whose property it is located. It already streams data to the MesoWest¹ weather reporting system used by the National Weather Service and many other groups. It has both power and internet connectivity and is located on private property. The weather station is located atop the terminus for the ski lift – which is an unacceptable placement for an AWOS system. Another more stable location adjacent to the lift would have to be developed.

Squaw Peak (FAA site) The FAA site is located at the top of Squaw Peak approximately ¼ mile up the mountain top from the Siberia ski lift which is approximately 170 feet lower in elevation. The FAA has a VOR (SWR) transponder located at the summit. It has existing power and communications. It has phone lines but no internet service. It has back-up power and a heated building housing existing navigation and communications equipment. Additionally this site is closely aligned to the Truckee Airport as a standard radio navigation waypoint. The FCC would likely require a radio spectrum analysis to assure that the radio component of the AWOS would not interfere with existing communications equipment located there. Additionally a tower/platform would likely be required for the AWOS equipment.

Squaw Peak (Resort side) has an existing weather station operated by the Squaw Valley Resort. The current weather station is located in the Ski Patrol hut approximately 200 feet south of the Siberia lift Terminal building. The Resort plans to completely rebuild the Siberia

¹ MesoWest was created to provide access to current and archived weather observations across the United States. It is used by the National Weather Service to aid in forecasting, by researchers to understand severe weather events, and by the public for personal use.

chair lift this summer (2015). They will be laying new power and communications lines along with other infrastructure improvements. The current location, the ski hut probably receives some interference from southerly winds due to proximity with Squaw Peak. If the AWOS were to be located at the new Siberia Ski lift the tower/platform and power/communications could be integrated during the building process. Like any of the resort ski lift locations it would have to be located some distance from the chair lift terminus for safety reasons.

[Alpine Ski Resort-Ward Peak](#) is located at 8575 feet approximately 2 ¾ miles south of Squaw Peak. While this would be ideal to locate an AWOS atop the terminal building for the Summit Chair Lift, this would not be acceptable for safety reasons. However barring disapproval by the U.S. Forest Service, which controls land use in that area, Jeff Goldstone, the Mountain Manager for Alpine did not see significant problems with placing an AWOS in the general vicinity of Alpine Meadow's own weather equipment which is located approximately [500-700 feet south-west](#) of the Summit Chair terminus.

Summary: Each of the above locations would be suitable for an AWOS, should the Board give direction to continue with the project. Specific MOU's would need to be developed outlining the responsibilities of all parties concerned.

As a note Greg McCurdy from the Desert Research Institute has indicated that while there are micro variances in weather conditions along the ridge line from Alpine to Highway 80, readings will remain relatively consistent no matter where an AWOS is located.

Component Considerations

Because of limitations imposed by the FAA only a limited number weather instruments are certified for use. Whether to place instruments on a tower, work platform or rooftop location is dependent on the final location chosen. FCC requirements and permits would determine the radio communications equipment used. In any case, consideration for maintenance, security and power/communications would be necessary during the installation process. Prefab [Modular work platforms](#) are available to help raise components above anticipated snowfall levels. Contact was made with the [Colorado Mountain AWOS](#) Program administration who indicated that they have 12 mountain top AWOS sites on their higher mountain top.

Cost Estimates

It is difficult to determine a final cost for placing an AWOS system atop the Sierra Crest. The ACAT subcommittee did meet with the Vaisala representative, Jerry Kirkpatrick our current airport AWOS vendor. He stated that for equipment - in general terms a Type I AWOS (the most basic system) would run around \$50,000 and a Type III would run approximately \$70,000. All of the AWOS systems include the automatic radio reporting communications equipment. Installation for any of these systems could double the price, depending on the variables. Therefore to purchase and install an AWOS system would cost between \$90,000

and \$140,000, depending on the configuration of the system. Jerry Kirkpatrick theVIASALA representative indicated that they can build a system with whatever structural platforms, fold down towers, etc., that are necessary. For budgeting purposes I would assume cost for installation would be towards the high side, however equipment costs should be very much in keeping with the norm.

In addition to the above onetime costs, there is a tri-annual inspection and calibration fee of approximately \$5000 a year; and whatever lease arrangements might be necessary for the placement of the equipment. Hopefully if a partnership is developed with one of the ski-resorts this would be negligible.

Certification

Permits and Certification are necessary from both the FAA and FCC for the weather system and communications system. In addition building permits might be necessary from Placer County and the Forest Service –depending on physical location. The following applications are necessary to begin the process.

FAA Form 7460-1 “Notice of Proposed Construction or Alteration”
FCC “Application for VHF and or UHF License

Subcommittee Recommendations

There are three alternatives considered for this project.

1. Install and maintain an FAA certified AWOS with automated radio transmission on the appropriate frequency for private planes transiting the Sierra Crest.
2. Augment or replace an existing resort mountain top weather system and feed the data to our airport web pages and the Mesowest system, which is used by a number of government and private parties. This data would not be available to pilots in the air.
3. Take no action.

Augmenting or replacing existing weather equipment while significantly less expensive, is not advisable. The main reason for a certified AWOS is to provide real-time radio broadcast information to pilots in route before they reach the summit area. Likewise to take no action fails to recognize the inherent hazard for the large number of private pilot’s activity in the region. A crash in this area would most likely cause loss of life, and the possibility of fire in the surrounding forest land.

It is the recommendation of this ACAT subcommittee that a new certified AWOS be placed at the Alpine Meadows Ward Peak site. Pilot Safety equates to community safety and the safety of aircraft using our airport should be of the highest priority. Alpine Meadows is recommended for the site because of the availability of power, telephone and internet infrastructure. Ward Peak also offers an unobstructed location for wind measurement from

all four compass points. In addition it is reachable for maintenance without undue hardship. Should Squaw-Alpine favor the joint venture our AWOS site would provide them with accurate weather data on a consistent basis and the National Weather Service would have a much more reliable weather reporting site.

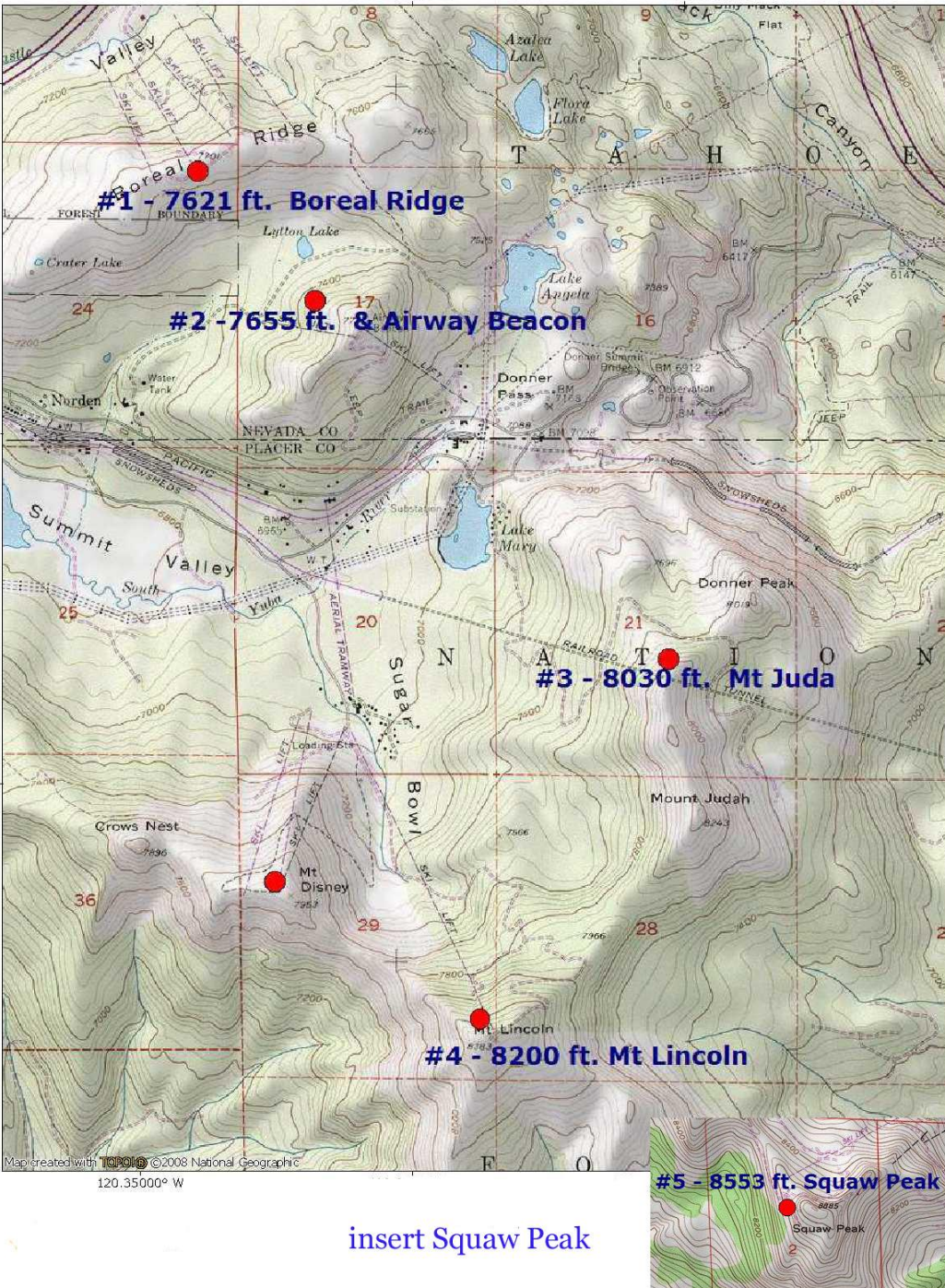
Should direction be given to proceed the next steps would be:

1. Obtain permission and MOU with Squaw-Alpine
2. Obtain approval from Forest Service
3. Submit FAA and FCC applications
4. Develop RFP for project

Footnote: HWOS (Hazardous Weather Observation Systems)

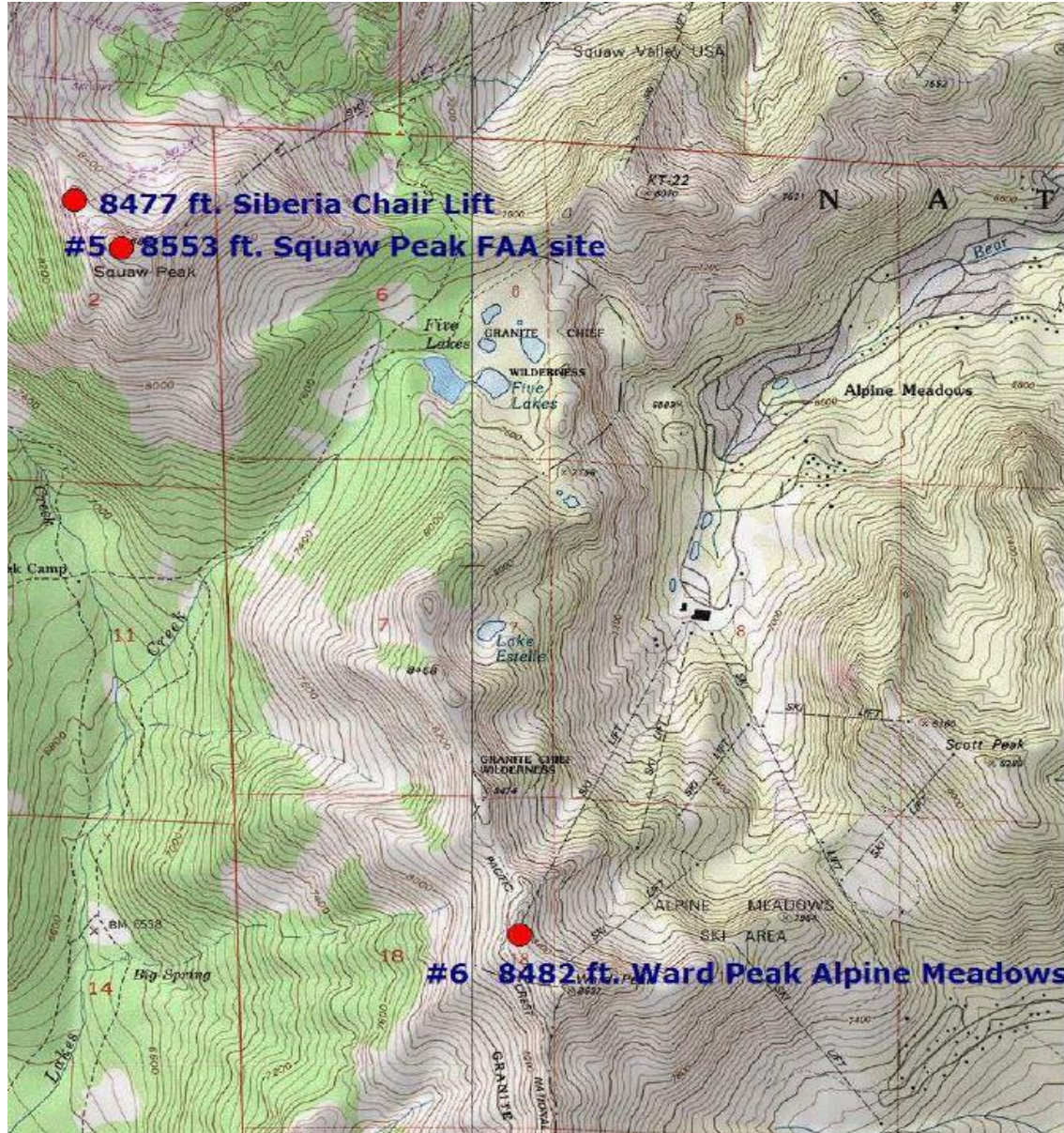
The Colorado Air Force Academy Airport uses a networked group of AWOS stations to alert and predict acute weather phenomena such as wind shear due to thunderstorm activity which the TTAP might wish to explore as part of the airport wide safety assessment in the future.

POSSIBLE LOCATIONS FOR AN AWOS



insert Squaw Peak

POSSIBLE LOCATIONS FOR AWOS – SQUAW VALLEY - ALPINE





U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service
2350 Raggio Parkway
Reno, Nevada 89512

May 7, 2015

Truckee Tahoe Airport District
Attn: Tom Combs ACAT
10356 Truckee Airport Road
Truckee, CA 96161

Dear Truckee Tahoe Airport Board of Directors and Federal Aviation Administration,
Western District Office:

We are writing this letter is to express our strong support for placing an FAA certified AWOS (Automated Weather Observation System) on the Sierra Crest between Alpine Meadows and Donner Pass. This location is ideal for monitoring weather conditions impacting the safety of both aviation and surface transportation over the Sierra and for avalanche danger as well. Because of its proximity to 1-80, the data would be especially valuable for our "weather watch" with respect to safety at the Truckee airport. Weather observations at mountain crests are rare nationwide and observations in the Sierra are in general few and far between. Thus, the data would also be used to improve forecast tools and for the research of mountain meteorology issues such as estimating snow-to-liquid ratios.

This proposed AWOS would be of great value for operations and research supporting the National Weather Service mission of protecting lives and property. Thank you for your consideration of this proposal. For questions, please call Jon (775) 673-8100 ext. 222, or Zach at (775) 673-8100.

Sincerely,

Jon Mittelstadt
Meteorologist-in-Charge

Zach Tolby
Avalanche Program Manager



Alpine Resort Top of Summit Chair – Ward Peak



**Alpine's Weather Station
Ward Peak**



Approximate Location of existing weather station



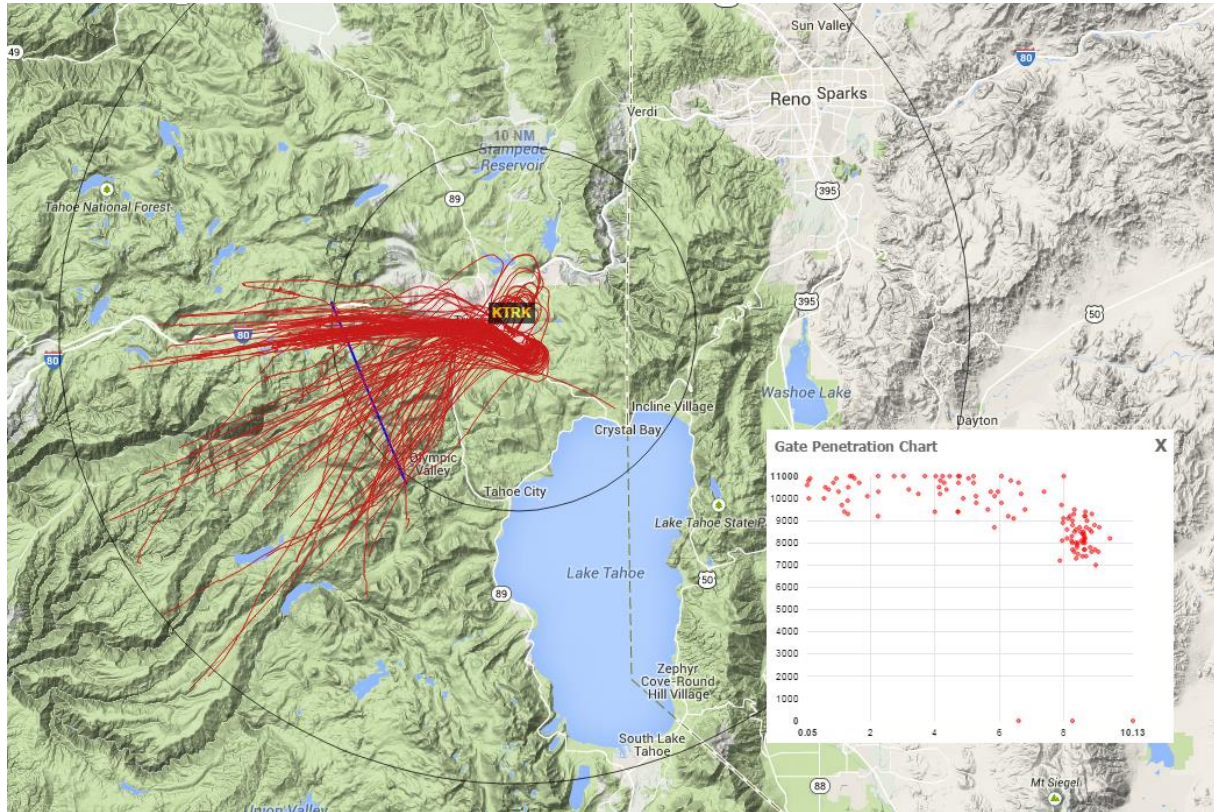
Possible Squaw Valley AWOS Sites



Typical AWOS Equipment



Sample “Gate” Pictorial Representation of Air Traffic from Squaw Valley to Donner Summit Ground to 11,000 msl 1 month



Sample Prefab Work Platform

[Work Platforms - Modular Platforms - Maintenance Platforms](#)



Appendix

SQUAW VALLEY

Monday January 12, 2015

I met with Will Paden and Curtis Crook. Curtis Crook is the patrol director Will Paden is in charge of avalanche forecasting.

There are numerous localized anemometers at the each of the lift top terminals. The main reporting weather station is atop the Siberia lift, specifically located at the ski patrol shack which is located approximately 200 feet below the summit. Equipment has been in place for 30 years and is replaced periodically as needed. Currently equipment failures occur rather often 50% estimated due to instrument failure and 50% due to data failures. Rime ice is a particular problem when the weather conditions are favorable for formation. They use some of the Phil Taylor equipment specifically the heated anemometer rotor system probably the model WS-3.

The anemometer is the wind cup version. The National Weather Service provides assistance in troubleshooting only. The weather station sits on private land. It should be noted that the nearby FAA site sits on Forest Service land. The data is transmitted via a phone line link to the village floor.

Squaw current time captures wind, direction, temperature, humidity, at the summit. They do not report the humidity reading. In terms of equipment needs they have the usual need for replacement of worn and outdated equipment and they would specifically rather send data via wireless link to the valley floor.

One of the most beneficial partnerships might come from the replacement of the Siberia lift, which will occur at this summer. It would be an opportune time to develop and install a weather tower with the necessary infrastructure, including electrical and network needs. Both individuals seemed enthusiastic about partnering with the airport and indicated that Andrew Wirth would most likely be receptive to working with us.

Alpine ski resort

January 12, 2015

Evan Salke dispatch 581-8238 cell 412-1230

Jeff Goldstone is patrol and mountain manager his assistant manager is Brian Slusser.

The Alpine weather station system is more extensive than that at Squaw Valley. The equipment is replaced as needed and it varies as to when this takes place. The overall master data logger was replaced between two and eight years ago. Their information is disseminated every 15 minutes by their I.T. department. In addition certain employees of Alpine are able to access weather data outside of the Alpine network. One of their best features is the rather robust graphical interface for displaying weather information that they use. This is a

Campbell instrumentation package. They also use Phil Taylor anemometers. They have the same problems as all other crest weather stations with high relative humidity and winds. Evan indicated that their heaters do a fairly good job of melting snow. He was not in favor of using the ultrasonic anemometers, although they are testing one out. Almost all of Alpine Ski Resort is on Forest Service Property but he indicated that it is not necessary to obtain Forest Service approval from most of the work they do.

There is a weather station placement at the top of the mountain which is fairly good except for perhaps an east wind which might provide some false readings. As indicated a data dump via a land line is preferred, which he feels it is far superior to that of a Wi-Fi network which would have more dropped packets.

Evan appears to be very knowledgeable about the workings of the weather stations at Alpine and has an excellent programming knowledge for the graphical interface to the data. Evan indicated that Jeff Goldstein would have to make any who decisions regarding cooperation with us but saw no impediments. Alpine would like to replace the software package that they currently use with an updated version.

Alpine Meadow Discussion with Jeff Goldstone 3/21/2015

On 3/21/15 I spoke with Jeff Goldstone, Patrol and Mountain Manager, at Alpine Meadows. Jeff and I had a very candid conversation about placing an AWOS in the area of the Summit Chair lift (Ward Peak). I told him the ideal location from our perspective would be atop the building located next to the Summit lift terminus. Jeff pointed out a couple of issues regarding placement at that location. There could be issues of Forest Service approval and possible disapproval by Alpine's marketing department; although these are certainly not insurmountable. However Jeff pointed out that there was a liability/safety issue that while remote, was not inconceivable. Should an antenna structure or other weather related equipment disassemble or strike the adjacent chair lift during strong winds or severe rime icing there would be a substantial liability issue. I agreed with him that while remote, it was probably not worth the possible repercussions to consider placement at that location.

Jeff did state that barring disapproval by the U.S. Forest Service, which controls land use in that area, he did not see significant problems with placing an AWOS in the general vicinity of Alpine Meadow's own wind meter which is located approximately 500-700 feet south-west of the Summit Chair terminus. While this would not be the ideal location, in terms of power and communications, it is suitable as long as signal loss is not an issue. The cost of retrenching the existing lines (power and comm lines) is unknown, but most likely doable. It should be noted that the liability issue of placing our equipment adjacent to any ski lift structure would be similar to that of Alpine's concerns. Therefore should the Siberia lift at Squaw Valley be chosen, the same issue would have to be addressed.

Colorado Mountain top project

Jan 20th

Spoke with Christine Eldridge and T.K. Gwin (their AWOS expert)

They have 12 sites and the individual at Vaisala that we should talk to when it comes time to build is Jim Nulley, who worked for a different vendor at the time but he was the tech that actually worked on the sites they built.

Curtis Nation at CDOT can tell us about what replacement parts we should stock, which equipment breaks down etc.

Equipment – They are using AWOS III p-t (precip and thunder strike) system. Apparently FAA doesn't like to deal with AWOS I and II systems, doesn't fit into their overarching scheme of things. They haven't had a real issues with the ceilometers, however they also get rime ice and you need to be careful about ice/snow falling from other equipment and damaging their equipment, they made rain buckets to put over the top of their equipment so when snow fell, it didn't damage equipment.

They did away with all their anemometers and now use only the ultrasonic models for wind heaters use about 10 amps. Vaisala has heavy duty heaters. Vaisala also has equipment that can use both wireless and microwave to transmit data. Each of their sites has a discrete radio freq.

When asked what the biggest problems would be TK said

- Spectrum analysis

- Access

- Forest Service

- FAA at least at the time they were doing it, didn't want to contribute much and didn't want to contribute to the power bill.

Individuals and Entities Contacted for Research

Current Vendor for TTAP AWOS

Vaisala.com (AWOS Sales) Jerry Kirkpatrick

National Weather Service Reno

Zack Tolby 970.261.6170 cell [<zack.tolby@noaa.gov>](mailto:zack.tolby@noaa.gov)

Desert Research Institute

[Greg McCurdy](#) He specializes in installation, operation, and maintenance of mountain [weather sites](#). 775.674.7165 or 775.722.2252 or 775.674.7010

Jeff Dean jeff.dean@dri.edu looking for places to install a ceilometer in the North Lake Tahoe/Truckee area.

Squaw Valley Resort

Will Paden 530.452.7260 wpaden@squaw.com

Curtis Crook 775.750.8143 Ski Patrol Director

Alpine Meadows

Evan Salke Avalanche Control cell 412-1230 evan@exwire.com 581-8238

Jeff Goldstone 581-8311 jgoldstone@squaw.com Patrol and Mountain Manager

Colorado AWOS Program

Christine Eldridge, *AWOS Program Administrator*, 303-512-5252

(direct), christine.eldridge@state.co.us, (TK Gwin) is the AWOS expert

FAA

Eric Stern is the AWOS tech (see Mike Cooke) eric.stern@faa.gov

Jeff Bogen Seattle (see Mike Cooke) Jeff.Bogen@faa.gov

Gil Mendez Tech with FAA took me up to the FAA site at Squaw
775-324-8504 Office 775-750-3786 Mobile

[MesoWest Surface Weather Maps](#)



Mountain Flying

Flying in the mountains offers beautiful scenery and views you can't get from the ground. It doesn't matter whether it's the Rockies, the Appalachians, or the Alps, there are scenes that are unforgettable. However, the mountains' beautiful scenery also involves more risks than flying over the flatlands.

Mountain Weather

Mountain weather can be a challenge for any pilot, especially those without a lot of experience. The Colorado Pilots Association has these weather minimums recommendations for inexperienced pilots.

- ⇒ **Maximum Winds aloft at 9,000 and 12,000 feet less than 25 knots.** Above 25 knots turbulence, updrafts, and downdrafts may exceed aircraft limitations.
- ⇒ **Ceiling at least 2,000 feet above all ridges and passes along the route.** This will help reduce the exposure to the most hazardous turbulence in most cases. This should be increased as the wind speed increases.
- ⇒ **Visibility of at least 10 miles.** Good visibility, well above the basic VFR requirements, is needed since you will generally be using pilotage for navigating. GPS is an excellent tool, but there are times when picking out a particular pass or valley will need to be done visually. Good visibility is the only way to be able to do that safely.

- ⇒ **Be aware of Mountain Waves.** During a mountain wave event, there are strong up and down drafts downwind from the ridges. The downdrafts in even moderate mountain waves exceed 1,000 feet per minute, making it difficult or impossible to cross the ridge. Rotors are caused by the wind shear and rotating moment underneath the crest of a mountain wave. The rotors will cause severe or greater turbulence and must be avoided.

Density Altitude

Failure to take density altitude into consideration has led many pilots into situations their aircraft couldn't handle. It is imperative that you understand how your aircraft performance is affected by density altitude. Even in the early evening, density altitude can be quite high and can present problems if you are not properly trained and prepared.

- ⇒ **True Airspeed increases.** True Airspeed is approximately 2% higher than Indicated Airspeed for every thousand feet of altitude. That means a longer ground run can be expected.
- ⇒ **Power decreases.** Normally aspirated engines put out less horsepower than at sea level (3% power loss per thousand feet), and you have two factors working against you.

Continued on Next Page



And if all else fails there is plan “B”



- ✓ Few moving parts
- ✓ Minimal upkeep
- ✓ Replace stones readily available
- ✓ Accurate with minimal down time

Tom Combs
ACAT